1st M.Tech End Sem Q.P. Reg. No. 2016 BRG

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

I SEMESTER M.TECH. (INDUSTRIAL BIOTECHNOLOGY) END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: TRANSPORT PHENOMENA IN BIOPROCESSING [BIO 5123]

REVISED CREDIT SYSTEM
(29/11/2016)

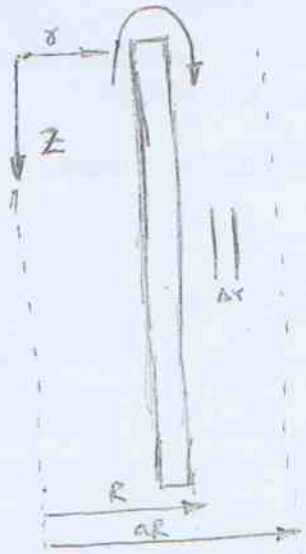
Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be assumed suitably
- Open Book exam (Transport Phenomena by BSL is allowed in the exam)

A. In a gas absorption experiment a viscous fluid flows upward through a small circular tube and downward in laminar flow on the outside. Set up a momentum balance over a shell of thickness Δr in the film as shown in figure. Note that the 'momentum in' and 'momentum out' arrows are always taken in the positive coordinate direction, even though in this problem the momentum is flowing through the cylindrical surfaces in the negative r direction. **8**

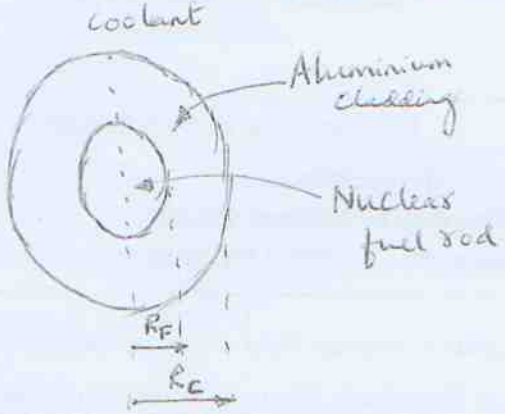
- Obtain the expression for velocity distribution in the falling film
- Obtain an expression for the mass rate of flow in the film.



1B. Explain 'creeping flow' and 'inviscid fluid' from Navier-Stokes equation **2**

2. Consider a long cylindrical nuclear fuel rod, surrounded by an annular layer of aluminium cladding, with in the fuel rod heat is produced by fission; this heat source depends on position approximately as $S_n = S_{no}[1 + b(r/R_F)^2]$ **10**

Here S_{no} and b are known constants, and r is the radial coordinate measured from the axis of the cylindrical fuel rod. Calculate the maximum temperature in the fuel rod if the outer surface of the cladding is in contact with a liquid coolant at temperature T_L. The heat transfer coefficient at the cladding –coolant interface is h_L and the thermal conductivities of the fuel rod and cladding are k_F and k_c



3A Using Buckingham Pi theorem show that power required for an impeller of the reactor without baffles in dimensionless number and also show that it is a function of other dimensionless numbers. **8**

3B Explain the significance of dimensionless numbers **2**

4A Find the temperature profile of unsteady state heat conduction in semi-infinite slab **10**

5A In studying the rate of leaching of a substance A from solid particles by a solvent B, we may postulate that the rate-controlling step is the diffusion of A from the particle surface through a stagnant liquid film thickness δ out into the main stream. The molar solubility of A in B is C_{A0}, and the concentration in the main stream is $C_{A\delta}$.

- Obtain a differential equation for C_A as function of z by making a mass balance of A over thin slab of thickness Δz. Assume that D_{AB} is constant and that A is only slightly soluble in B. Neglect the curvature of the particle.
- Show that, in the absence of chemical reaction in the liquid phase, the concentration profile is linear.
- Obtain the expression for rate of leaching

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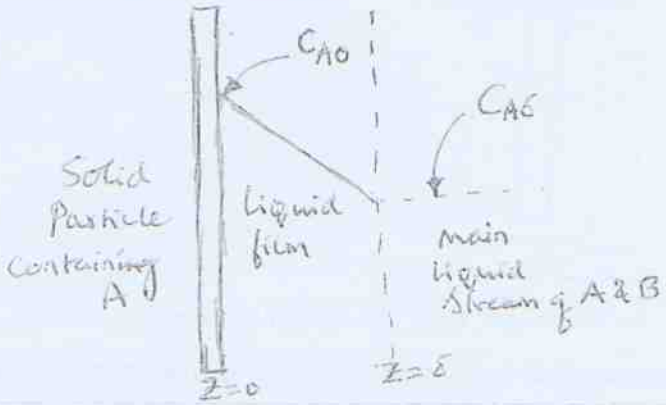

5B Consider a catalytic heterogeneous chemical reaction in which a reaction A →2B is carried out and assume reaction occurs instantaneously at the catalytic surface. Imagine that the catalytic particle is surrounded by a stagnant gas film through which A has to diffuse to reach the catalytic surface. Neglect the curvature of the particle. **4**

- Obtain the expression for concentration profile of A in stagnant gas film in terms of mole fraction of A